Postoperative Blepharoptosis After Modern Phacoemulsification Procedure

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• PURPOSE: To investigate the frequency of transient (1 month) and persistent (at least 6 months) postoperative ptosis following clear corneal sutureless phacoemulsification and to analyze the factors affecting them.
• DESIGN: Cohort study.
• METHODS: Patients who underwent phacoemulsification cataract surgery from October 2016 to June 2018 in a tertiary center were enrolled. Margin reflex distance 1 (MRD1), MRD2, and levator function were measured and facial photography was taken before, 1 month, and at least 6 months after the surgery. Clinical ptosis was defined as any postoperative drop of MRD1 and clinically significant ptosis as MRD1 drop of ≥2 mm. Photo-based ptosis was assessed by a masked oculofacial plastic surgeon at the end of the study.
• RESULTS: A total of 234 patients (313 eyelids) were included. The majority of surgeries were performed by senior residents (65.5%, 205/313) and under topical anesthesia (78.0%, 244/313). Persistent clinical, clinically significant, and photo-based ptosis were 25.4% (71/279), 3.2% (9/279), and 3.3% (9/276). Eyelids with persistent postoperative ptosis showed a significantly ($P = .03$) lower preoperative levator function (13.9 vs 15.8 mm). No other factor was significantly different between the eyelids with and without postoperative ptosis.
• CONCLUSION: Persistent clinically significant ptosis was observed in more than 3% of patients undergoing clear corneal sutureless phacoemulsification cataract surgery. It should be counseled preoperatively. Lower preoperative levator function was significantly associated with a higher frequency of postoperative ptosis. Duration of surgery, level of surgeons, and other variables did not have any significant effect on the frequency of postoperative ptosis. (Am J Ophthalmol 2020;213:17–23. © 2020 Elsevier Inc. All rights reserved.)

POSTOPERATIVE PTOSIS IS AN ACQUIRED PTOSIS occurring after intraocular surgery.[1] It is an issue beyond the appearance that could impair quality of life.[2] The etiology of postoperative ptosis after cataract surgery is multifactorial and could result from levator muscle injury through mechanical, myotoxicity, and or neurotoxicity.[3–5] Although this complication generally gradually improves within 3 months (mostly 1-2 months) after the surgery (Transient), it may remain even after 6 months (Persistent).[3]

Its frequency has been dropped by changing the procedure from extracapsular cataract extraction to phacoemulsification.[6–8] Modern phacoemulsification procedure is, in this study, defined as cataract extraction and intraocular lens implantation through a small sutureless clear corneal incision without globe and or extraocular muscle fixation and conjunctival/scleral incision. Literature review shows 15 previous studies[2,6–19] on postoperative ptosis after cataract surgery, among which 2[18,19] were after modern phacoemulsification procedure. Frequency of transient and persistent postoperative ptosis after old techniques of cataract surgery have been 0%-71%[6–8,10–13,15,16] and 2.8%-49%,[2,6,9,14] respectively. On the other hand, although the frequency of transient (3 months) postoperative ptosis (≥0.5 mm drop of upper eyelid) after modern phacoemulsification procedure was reported to be 41% in one study,[18] the other one[19] did not observe any significant change 6 months after the procedure. Both studies, however, had a small sample size, no assessment of factors especially intraoperative factors on the frequency of postoperative ptosis, and no assessment of persistent postoperative ptosis in one[18] of them.

Therefore, this cohort study was designed to report the frequency of postoperative ptosis in 1 month and at least 6 months after modern phacoemulsification procedure and analyse the factors affecting them.

METHODS

THIS IS A COHORT STUDY ON PATIENTS WHO UNDERWENT phacoemulsification surgery at a university-based hospital (Rassoul Akram Hospital, Tehran, Iran) from October 2016 to June 2018. Informed consent and ethic committee approval (IUMS-9411257006) were obtained, and the study adhered to the tenets of the Declaration of Helsinki.

Patients who were scheduled for phacoemulsification were included. Patients with history of intraocular surgery within the last 6 months, previous eyelid or orbital surgery, any disease affecting the eyelid and globe position, use of

Accepted for publication Dec 20, 2019.
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0002-9394/$36.00
https://doi.org/10.1016/j.ajo.2019.12.023

topical steroid within the last 3 months, upper face botulinum toxin injection within the last 6 months, and missing the last follow-up (≥6 months) were excluded.

They were examined and photographed by the same person (PA) within 24 hours before, 1 month, and at least 6 months after the surgery. Eyelid parameters,[20] ocular motility, and eye examinations were recorded. Type and duration of surgery, level of surgeon, injected medications, and type or duration of postoperative medications were also documented. Patients with consecutively bilateral procedures underwent the same examination and recording of the data for each eye, separately.

Margin-reflex distance 1 (MRD1) and 2 (MRD2) were the distance from the upper and lower eyelid margins to the corneal light reflex in the primary position when the patient gazed at a pen light placed 50 cm away straightly. Levator function was recorded as upper eyelid excursion from downgaze to upgaze with the frontalis muscle immobilized manually by the examiner's thumb. Upper eyelid crease was measured from the eyelid margin. Facial photographs were taken on primary position (13.1-megapixel Sony Xperia C6603 digital camera) from the same distance (25 inches) and under the same lighting conditions.

Procedures were performed by the attending surgeon, fellows, senior residents, or junior residents. Reusable Lieberman adjustable eyelid speculum without bridle suture was used in all patients. Phacoemulsification procedure was performed with a sutureless, temporal, clear corneal incision (3.2-mm) under general, topical, or in a very few patients retrobulbar anesthesia. Intracameral anesthesia was also applied in all patients. At the surgeon's discretion, some patients received a subconjunctival injection of cefazolin and betamethasone into the inferior fornix at the end of surgery. Eye dressing was discontinued within 24 hours after the surgery.

Primary outcome measure was postoperative ptosis. Postoperative drop of ≥0.5-mm MRD1 was defined as clinical postoperative ptosis and ≥2 mm as clinically significant postoperative ptosis. A composite of 3 primary gaze photos (before, 1 month, and at least 6 months) was digitally made for each patient. The set of 3 photos was then subjectively assessed by a masked experienced oculofacial plastic surgeon (M.B.K.) at the end of the study (photo-based postoperative ptosis). Secondary outcome measure was assessment of different variables, especially surgeon's level and duration of surgery on postoperative ptosis.

• **STATISTICAL ANALYSES:** All the statistical analyses were performed using SPSS for Windows software, version 22 (SPSS, Inc, Chicago, IL). Mann-Whitney *U* and Kruskal-Wallis H (continuous variables), χ^2 test (categorical variables), and Wilcoxon (comparing pre- and postoperative continuous variables) tests were used for analysis.

Receiver operating characteristic curve analysis was performed to find out the clinically significant postoperative ptosis based on change in MRD1 and photo-based postoperative ptosis. Area under the curve (AUC) of <0.3 was considered as weak, 0.3-0.7 as moderate, and >0.7 as strong accuracy.

At the eye level, outcome variables (clinically significant ptosis at 2 follow-up times) was assessed using generalized estimating equation (GEE) models (univariate and multivariate) to account for including both eyes from some of the patients. Results were considered significant at $P < .05$.

RESULTS

INCLUDED WERE 234 PATIENTS (313 EYELIDS). ONE-MONTH clinical examination was performed on 207 patients (275 eyelids) and photography on 195 patients (258 eyelids). Final follow-up measurements and photography were recorded in 210 (279 eyelids) and 208 (276 eyelids) patients, respectively. Different numbers were because of either loss of follow-up for clinical measurement or missing the photos.

Mean age was 64.9 (SD=10.8) years. More than half of the patients (55.6%, 130/234) were female. The procedures were performed under either topical anesthesia in the majority of the eyes (78%, 244/313), general (20.4%, 64/313) or retrobulbar (1.6%, 5/313) anesthesia by senior residents (65.5%, 205/313), junior residents (20.4%, 64/313), fellows (8.3%, 26/313), or attending surgeons (5.8%, 18/313). Mean duration of procedures was 40.5 minutes (SD=17.3), and almost one third (31.3%, 98/313) of the cases had subconjunctival injection of betamethasone at the end of the procedure. Mean first and last follow times were 45.6 (SD=15.1) and 240.4 (SD=57.2) days, respectively.

• **TRANSIENT AND PERSISTENT POSTOPERATIVE PTOSIS:** Mean preoperative MRD1 of 2.7 mm (SD=1.3) significantly ($P < .0001$) dropped to 2.2 mm (SD=1.3) in the first and returned to almost its preoperative value (2.6 mm, SD=1.3, $P = .09$) in the last follow-up. Postoperative drop of MRD1 was from 0.5 to 4 mm on both follow-up times, even though MRD1 increased in few eyelids (Table 1).

Clinical postoperative ptosis (≥0.5 mm drop of MRD1) was observed in 40% (110/275) of the eyelids in the first follow-up and in 25.4% (71/279) in the last follow-up (Table 1). Photo-based ptosis, however, was recorded in 6.2% (16/258) and 3.3% (9/276) of the eyelids in the first and last follow-up times, respectively.

Postoperative drop of MRD1 had a significantly moderate accuracy of detecting photo-based ptosis according to the receiver operating characteristic curve analysis

TABLE 1. Comparing Pre- Versus Postoperative Margin Reflex Distance 1 (MRD1), Margin Reflex Distance 2 (MRD2), and Eyelid Crease Height After Phacoemulsification Cataract Surgery

Variables	Preoperative	First Follow-up (n = 275 Eyelids)	*P* Value (Compared With Preop)	Last Follow-up (n = 279 Eyelids)	*P* Value (Compared With Preop)
Follow-up, d, mean (SD)	–	45.6 (15.1)	–	240.4 (57.2)	–
MRD1, mm, mean (SD)	2.7 (1.3)	2.2 (1.3)	<.0001	2.6 (1.3)	.099
MRD1 change, mm, % (n)					
Decreased					
4.0	–	0.4 (1)	–	0.4 (1)	–
3.0		0.4 (1)		0.4 (1)	
2.5		0.4 (1)		0	
2.0		8.7 (24)		2.5 (7)	
1.5		3.3 (9)		1.4 (4)	
1.0		22.2 (61)		12.9 (36)	
0.5		4.7 (13)		7.9 (22)	
No change		47.6 (131)		56.6 (158)	
Increased		12.4 (34)		18.0 (50)	
MRD2, mm, mean (SD)	4.7 (0.8)	4.6 (0.9)	.005	4.7 (0.8)	.272
Crease height, mm, mean (SD)	8.3 (3.0)	8.6 (3.1)	<.0001	9.2 (3.5)	<.0001

(AUC=0.77, 95% confidence interval [CI]= 0.68-0.86, $P = .04$) in which the lowest cut-off value (corresponding to a specificity=1) was 2 mm. It means that all the patients with photo-based postoperative ptosis had ≥2 mm drop of MRD1.

Therefore, frequency of clinically significant postoperative ptosis (≥2 mm drop of MRD1) was 9.8% (27/275) and 3.2% (9/279) at the first and last follow-up times.

Transient clinically significant ptosis was associated with preoperative MRD1 (odds ratio=1.38, 95% CI=1.05-1.81, $P = .02$) and subconjunctival betamethasone injection (odds ratio=0.37, 95% CI=0.13-1.10, $P = .07$) in univariate analysis (GEE). None of them remained significant in the multiple model of GEE ($P > .05$).

Persistent clinically significant ptosis was not significantly associated with any variable ($0.17 \leq P \leq .70$) except preoperative levator function ($P = .03$) in univariate analysis of GEE. Therefore, multiple modeling of GEE was not performed for persistent postoperative ptosis. Preoperative mean levator function was significantly ($P = .03$) lower (odds ratio=0.69, 95% CI=0.49-0.95) in patients with (13.9 mm, SD=2.8) than without (15.8 mm, SD=2.3) persistent postoperative ptosis. Eyelid crease height showed a significant ($P < .0001$) increase in the first and last follow-up measurements (Table 1).

Junior residents had a significantly ($P < .001$) longer mean duration of surgery (51 minutes, SD=14) than senior residents (37.8, SD=12.4), fellows (36.9, SD=35.9), and attending surgeons (36.4, SD=21). However, the frequency of persistent clinically significant postoperative ptosis was not significantly different ($P = .1$) between the attending surgeon (11.1%, 2/18), fellows (4.3%, 1/21), senior residents (3.4%, 6/176), and junior residents (0/9).

DISCUSSION

POSTOPERATIVE PTOSIS IS A WELL-DESCRIBED BUT POORLY understood complication after intraocular procedures. It is frequently overlooked, and patients are rarely warned as part of preoperative informed consent.[2] More than 80% of subjects with postoperative ptosis have reported its impact on their quality of life, because of which they are willing to have eyelid surgery.[2]

There are 15 Studies (Table 2) on post–cataract surgery ptosis with different techniques, ptosis definitions, and frequencies. Although some[2,7,13,14,21,22] have considered ≥2 mm drop of MRD1 as postoperative ptosis definition, others[6,11,12,18] reported the frequency based on each millimeter drop of MRD1. Of 15 articles, modern phacoemulsification procedure was the technique in only 2 publications.[18,19] One of them[18] just reported 3-month postoperative ptosis of 41% (MRD1 drop of ≥0.5 mm) without assessing longer follow-up time. In contrast, the other one[19] did not observe any significant drop of MRD1 at 6 months after the surgery.

The present study, to our knowledge, is the largest series that has assessed postoperative ptosis after modern phacoemulsification surgery. All the procedures were performed by different surgeons at different levels. Furthermore, both clinical measurement (change in MRD1) and photo analysis (by 1 observer) were used for reporting the frequency of postoperative ptosis. Receiver operating characteristic curve analysis was also used to determine an acceptable cut-off point for clinically significant ptosis.

Transient *clinical*, *clinically significant*, and *photo-based postoperative ptosis* were 40%, 9.8%, and 6.2%, respectively. Upper eyelid ptosis became persistent in 25.4%, 3.2%, and

TABLE 2. Studies on Postoperative Ptosis (PP) After Extracapsular Cataract Extraction (ECCE) and Phacoemulsification (Phaco.) Procedures Assessing the Upper Eyelid Position With Margin Reflex Distance 1 (MRD1) and or Photography

	Authors	Year	Number of Eyes, Type of procedure	Assessment; Definition of PP	Follow-up Time	Frequency of PP	Associated Procedure	Factors Significantly Increasing PP
1	Kaplan et al[6]	1985	45, ECCE 148 Phaco. (scleral incision)	Clinical and photography; any drop of MRD1	8 weeks 6 mo	71% in ECCE 50% in phaco. 49% in Total	Nadbath/Van Lint block ± bridle suture or sup rectus grasping	–Combination of sup rectus retraction suture with Van Lint nerve block
2	Shiue et al[9,a]	1987	106, ECCE	Not available	6 mo	2.8%	Not available	Not available
3	Loeffler et al[10]	1990	79, ECCE and Phaco (scleral incision)	Photography; any drop of MRD1	3 mo	Subconjunctival bridle: 4% (2 mm)/ 38.2% (0.5 mm) Transconjunctival bridle: 19% (2 mm)/ 48.9% (0.5 mm)	Subconjunctival vs transconjunctival, bridle suture	–Transconjunctival bridle suture
4	Ropo et al[11]	1992	64, ECCE	Clinical; any drop of MRD1	1 mo	0.01%	Bridle suture	No effect of general and periocular anesthesia
5	Feibel et al[12]	1993	317, ECCE	Photography; ≥2 mm drop of MRD1	3 mo	5.7%	No bridle suture	No effect of anesthesia type
6	Singh et al[13]	1997	220, ECCE	Clinical; ≥2 mm drop of MRD1	6 wk	23.3% without speculum 44.4% with speculum	Bridle suture ± speculum	–Speculum –Bridle suture
7	Hosal et al[14]	1998	124, ECCE	Clinical; ≥2 mm drop of MRD1	6 mo	7.3%	Bridle suture	–Preoperative MRD1 –Volume of local anesthetic
8	Sundar et al[15]	1999	150, ECCE	Clinical; any drop in MRD1	3 mo	4%	Peribulbar anesthesia	–Local anesthetic
9	Kawa et al[8,a]	2000	72, Phaco. (scleral incision)	2 mm drop of MRD1	3 d	1.4%	Bridle suture	–Bridle suture –No effect of anesthesia type
10	Patel et al[16]	2002	66, Phaco. (scleral/ corneal incision)	Clinical and photography; ≥2 mm drop of MRD1	3 mo	10.5% in superior 10.7% in temporal corneal approach	Superior scleral incision with bridle vs temporal corneal incision without bridle Peribulbar anesthesia	–No effect of bridle suture –No effect of wound site
11	Altieri et al[2]	2005	ECCE:34 Phaco.:97	Clinical; ≥2 mm drop of MRD1	6 mo	8.8% in ECCE 4.1% in phaco.	Local anesthesia	–NO

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TABLE 2. Studies on Postoperative Ptosis (PP) After Extracapsular Cataract Extraction (ECCE) and Phacoemulsification (Phaco.) Procedures Assessing the Upper Eyelid Position With Margin Reflex Distance 1 (MRD1) and or Photography (*Continued*)

	Authors	Year	Number of Eyes, Type of procedure	Assessment; Definition of PP	Follow-up Time	Frequency of PP	Associated Procedure	Factors Significantly Increasing PP
12	Puvanachandra et al[7]	2010	60, ECCE 60, phaco.	Clinical and photography; ≥2 mm drop of MRD1	6 wk	18% in ECCE 0% in phaco.	ECCE with superior rectus bridle suture, retrobulbar anaesthesia and a 10-mm superior limbal incision No superior rectus bridle suture, topical and intracameral anaesthesia and a 3- to 4-mm sutureless, temporal, clear corneal incision	–ECCE
13	Chaudhari et al[17]	2018	260, small incision cataract surgery	Clinically and photography; ≥2 mm drop of MRD1	6 mo	11.5% with and 7.7% without bridle suture	± Bridle suture	–Bridle suture, –Longer operative time
Modern Phacoemulsification procedure								
14	Tamaki et al[18]	2016	Phaco. (sutureless clear corneal incision)	Photography; ≥0.5 mm drop of MRD1	3 mo	41%	Topical and intracameral anesthesia,	No effect of incision site
15	Marqués-Fernández et al[19]	2019	Phaco. (sutureless clear corneal incision)	Photography; ≥0.5 mm drop of MRD1	6 mo	No report of prevalence, Postoperative MRD1 median did not change	Topical or peribulbar anesthesia	–No effect of duration of operation
16	Kashkouli et al (current study)	2019	278, Phaco. (sutureless clear corneal incision)	Clinical and photography Photo-based	≥0.5 mm drop of MRD1 1 mo ≥6 mo ≥2 mm drop of MRD1 1 mo ≥6 mo 1 mo ≥6 mo	40% (110/275) 25.4% (71/279) 9.8% (27/275) 3.2% (9/279) 6.2% (16/258) 3.3% (9/276)	Topical, general, or retrobulbar anesthesia	–Lower preoperative levator function –No effect of other factors

[a]The English full text was not available.

3.3% of cases, respectively. Table 2 shows how the frequency of postoperative ptosis has dropped from older techniques to the modern phacoemulsification one.

Intraoperative levator muscle injury could occur because of mechanical forces, myotoxicity, and/or neurotoxicity.[4] Some of proposed causes are eyelid edema,[12,14,21] bridle suture and superior rectus grasping,[6,8,10,13,23,24] size and location of the incision,[24] peribulbar[11,22] or retrobulbar[22,24] anesthetics, eyelid speculum,[13,16,25] narrower vertical palpebral apertures,[14] previous intraocular surgery,[6] prolonged patching, ocular massage,[9] lower preoperative levator function[13] and lower preoperative MRD1.[18] However, some studies reported no significant effect of age,[11,12,14] sex,[14] preoperative levator function,[12,14,22] eyelid crease,[12–14] eyelid edema,[6,13,14] bridle suture,[16] ocular wound site,[16,18] technique of anesthesia,[8,11,12] and anesthetic type[24] on postoperative ptosis. Therefore, it seems that attempting to predict the development of a postoperative ptosis is difficult.

Modern phacoemulsification procedure is performed under topical anesthesia with sutureless clear corneal incision and therefore avoids most of the proposed causes for the postoperative ptosis. All the preoperative (age, sex, MRD1, levator function, crease height), intraoperative (type of anesthesia, duration of surgery, level of surgeons), and postoperative (subconjunctival betamethasone injection, duration of topical steroid) variables were analyzed in which lower preoperative levator function was the only factor significantly associated with a higher frequency of persistent postoperative ptosis. Mean levator function was 13.9 and 15.8 mm in patients with and without persistent postoperative ptosis, respectively. We could not account for such a difference between the 2 groups.

Possible risk factors for postoperative ptosis could be eyelid speculum, type of anesthesia, pre-existing levator dehiscence, level of surgeon, and duration of surgery.

The speculum pulls the levator aponeurosis superiorly against the orbital rim and causes its dehiscence, inflammation, and/or edema.[10,11,13,16] In addition, sustained compressive forces from the speculum can cause crush injury to the delicate upper eyelid musculature and myoneural or myovascular connections.[5] Squeezing (orbicularis contracture) during local or topical anesthesia,[22,24] stiffer speculum,[26] and smaller palpebral apertures[14] might result in a greater force that may accentuate postoperative ptosis. In contrast to previous studies on vertical stretching of levator muscle, Mehat and associates[4] proposed that prolonged horizontal rather than vertical stretch of the eyelid is the potential contributing factor. Reusable, long arms and stiff specula lead to more force on the eyelids than softer disposable ones.[25] Huero and associates[3] believed that small speculum with short horizontal arms results in less trauma to the levator muscle. However, there is no randomized trial on the effect of different specula on postoperative ptosis. Lieberman stiff speculum was used in all the patients in our study.

The literature does not show a consensus on the effect of different types of anesthesia on postoperative ptosis because of different methods and volumes of anesthesia. The proposed pathophysiology of postoperative ptosis after local anesthesia injection are levator myotoxicity, neuromuscular blockade, and direct neurotoxic effect on oculomotor nerve.[4,11] Higher volumes of local anesthetic injection resulted in a higher frequency of persistent postoperative ptosis after ECCE.[14] It is assumed that postoperative ptosis would be less when the surgery is performed under general anesthesia because of no eyelid force against the speculum.[25] Two studies have compared general and local anesthesia in patients with extracapsular cataract surgery.[11,22] Whereas one[22] found a lower frequency of postoperative ptosis in patients with general rather than local anesthesia, another[11] reported no difference in frequency of transient postoperative ptosis in 2 types of anesthesia. Our results showed that the frequency of postoperative ptosis was not significantly different in patients with topical vs general nor topical vs retrobulbar anesthesia. However, the number of patients with retrobulbar anesthesia was too small (1.6%, 5/313) to draw a strong conclusion.

Postoperative ptosis is generally considered as an iatrogenic type of aponeurotic ptosis due to levator muscle dehiscence.[21,23,27,28] Likewise, we observed a significant increase of the mean eyelid crease height from 8.3 to 9.2 mm at the last follow-up (Table 1). A higher postoperative crease height may imply a levator dehiscence mechanism. Ocular surgery in patients with a subclinical ptosis may trigger impending dehiscence in the operative eye.[5] Some[22,23] proposed that patients with postoperative ptosis are more vulnerable to involutional changes such as weak attachment of levator aponeuroses to the tarsus. On the other hand, others[6,12,14] believed that presence of preoperative anatomic findings such as high eyelid crease, deep superior sulcus, and lash rotation (suggestive of subclinical levator dehiscence) are not necessarily predicting the postsurgical ptosis. Preoperative MRD1 was not significantly different in patients with and without postoperative ptosis in our study. Likewise, Kaplan and associates[6] stated that preoperative ptosis neither prevented nor induced further postoperative ptosis.

There is no agreement on the role of operative time on postoperative ptosis in the literature.[11,14,19] Longer time of surgery could contribute[14] or have no effect[11] on postoperative ptosis. Our results did not show a significant effect of the time of surgery on the frequency of postoperative ptosis. Furthermore, the frequency of postoperative ptosis (transient and persistent) was not significantly different between different levels of surgeons in our study. No study was available to compare to.

Because a small fraction of transient postoperative ptosis end with persistent postoperative ptosis in all the studies, it is recommended to delay the repair of postoperative ptosis for at least 6 months after cataract surgery.[6,22,23] However, because other facial aging changes (dermatochalasis,

eyebrow droopiness) are present, it is not clear how many would go through another surgery. Patients' perspective on postoperative ptosis was not evaluated in this study. Another limitation of this study could be a potential bias on the assessment of ptosis by clinical examination as well as presenting the photos to the observer in chronological sequence rather than randomized fashion.

In conclusion, persistent (≥6 months) clinically significant ptosis (≥2 mm) was observed in almost 3.5% of patients who underwent clear corneal sutureless phacoemulsification. Patients should be counseled about it preoperatively. Duration of surgery and the level of surgeons as well as other factors were not significantly associated with postoperative ptosis.

FUNDING/SUPPORT: IRAN UNIVERSITY EYE RESEARCH CENTER (IUMS-9411257006) HAS FUNDED THIS STUDY BUT HAD NO ROLE in the design or conduct of this research. Financial Disclosures: The authors indicate no financial support or conflicts of interest. All authors attest that they meet the current ICMJE criteria for authorship.

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